MAGNETOTRANSPORT INVESTIGATION OF BISMUTH CHALCOGENIDE TOPOLOGICAL INSULATORS

Abstract

by

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V_2VI_3 materials Bi_2Se_3 and Bi_2Te_3 with tetradymite rhombohedral layered structures consisting of repeating layers of Se(Te)–Bi–Se(Te)–Bi–Se(Te) are in a class of electronic materials called topological insulators (TIs) exhibiting a bulk band gap and band-crossing surface states supported by the non-trivial band topology of the TI. The topologically protected surface states are characterized by the electron spin locked perpendicular to the momentum (in the plane of the sample) leading to time reversal invariance that protects these conducting states against backscattering. Strong spin-orbit coupling in these materials leads to band inversion that results in a transition to the topological state. This research is part of the significant effort in perfecting techniques for producing high quality TI materials and studying the structural, electronic, and other characteristics of these novel quantum materials.

Bi_2Se_3 and Bi_2Te_3 thin films were studied experimentally using electrical transport techniques, with emphasis on resistivity, weak antilocalization, and differentiating bulk and surface carriers. Investigations were extended to the study of related systems ternary alloy $Bi_2Te_xSe_{3-x}$ along the range of x from 0 to 3 and Bi-chalcogenide materials doped with Mn to

promote the system to host a magnetization. All systems were grown by molecular beam epitaxy (MBE). Samples were grown at a range of thicknesses from 20nm to 200nm. Measurements of resistivity in Bi-chalcogenide materials, alloys, and heterostructures serve to establish the transport behavior of these materials with the aim of differentiating between bulk and surface conductance. Additional structural and magnetic measurements including x-ray diffraction, atomic force microscopy, transmission electron microscopy, angle resolved photoemission spectroscopy, x-ray absorption fine structure measurements, and superconducting quantum interference device magnetometry give further insight into the systems under study that allow for a complete description of electron transport through these materials.